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JOURNAL OF THE INSTITUTE OF PETROLEUM

FOUNDED 1913 INCORPORATED 1914

Vol. 28 DECEMBER 1942 No. 228

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Published by the Institute of Petroleum.
Address : c/o The Imperial College of Science and Technology, South Kensington, London, S.W.7.
Printed in Great Britain by Richard Clay and Company, Ltd., Bungay, Suffolk.

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Vol. 28. No. 228. December 1942.

CONSERVATION OF LUBRICATING OIL.*

The following is a report by the Oil Advisory Panel of the Transvaal Chamber of Mines, of which the Chairman is Mr. W. E. Gooday.

I. Storage and Issue.

(a) *Storage.*

Stocks of oil should not be stored in lean-to shelters, but in sheds providing proper protection.

Stocks in the mine stores should be so arranged that new deliveries can be placed in a position so that oils and greases would be withdrawn for issue in the same rotation as they have been received, thus avoiding any consignment being retained in store for undue time.

Where storage of lubricants is unavoidably out-of-doors, it is necessary to cover containers to protect them from the effects of weather, heat or wet. Drums should always be stored horizontally, and not on end.

In the case of insulating oils (transformer and switch oils), ingress of moisture affects the quality of these materials very seriously, and every effort should be made to store insulating oils under cover.

It is essential to ensure absolute cleanliness in the storage and issue of lubricants, for the most flagrant injury to lubricants is caused by allowing ingress of dust, dirt, moisture, and other impurities. Haphazard storage may detract from the value of lubricants, and possibly render them unfit for service.

Care should be taken to preserve the markings on containers, in order that the contents may always be easily identified, and to minimize risk of confusion in use.

In the storage of greases, care should be taken to maintain as equable a temperature as conditions will permit; for extremes are often the cause of separation of the constituents.

Stocks should be stacked so as to facilitate periodical examination, otherwise damaged containers hidden in a stack may leak slowly for a considerable period without detection of loss.

(b) *Containers.*

Containers that need to be cut open should not be cut more than is necessary, otherwise dirt and dust may enter. The four-gallon tin is becoming increasingly difficult to obtain, thus mines should be prepared for a proportionate increase in drum deliveries.

Before opening a barrel, its exterior should be cleaned thoroughly, to free it from any dirt that may have adhered to it in handling.

Mines should give the suppliers of lubricants an opportunity to accept returned empty containers prior to offering these to dealers.

Importers of lubricants have not usually been interested in the return of empty drums, but local manufacturers of greases are now anxious to obtain them.

Containers should always be handled carefully, so as to avoid damage in

* Received 4th November.

opening, or otherwise. When unloading drums, arrangements should be made for these to be dropped on to some material to absorb shock.

Where subsidiary distributing containers are used—possibly made on the mines—these should be preferably of sheet steel or tin, and not of material containing either lead or zinc, both of which metals may react with certain classes of lubricants.

Bucket-type containers are often emptied prematurely from time to time in order that the employee concerned can retain the bucket. This practice should cease.

Distributing containers should be examined regularly, kept scrupulously clean, and fitted with dust-proof covers to prevent impurities gaining access to the oil. They should be fitted with spouts of size designed to permit of oil being poured into syphon oilers, ring oil bearings, and other places without spilling.

All containers to be returned to stores, and the lubricant remaining in them to be removed. The idea that drainings are a perquisite available to the employee should be discouraged. It has been calculated that sometimes in four-gallon containers approximately one pint of oil remains and in forty-gallon drums one gallon.

(c) *Issue.*

The official responsible for lubricants should set an economical ration for given purposes; requisitions for amounts exceeding that ration should be accompanied by reasons. Issues of lubricant should be made, as far as possible, to the persons who will apply it to machinery. Where appropriate, issues should be limited to the minimum required for one shift.

Pouring oil from drums through the bung can be wasteful, and, where possible, a faucet should be employed.

Oil for use underground should be distributed in small containers, for the issuing of unnecessarily large quantities of oil tends towards waste, particularly with Natives prone to use the oil for purposes of bodily adornment or for dressing boots.

Rockdrill lubricators that are filled on the surface should be returned to stores with the unused oil intact.

Apart from the reduction of quantity of oil per issue, it may be advisable in some instances, which might be dictated by the size of packing available, to reduce the number of issues in a given time.

II. Application.

(a) *Feeds.*

It is recommended that managers and engineers should consider the installation of more economical means of applying lubricants to machinery, such as force-feed mechanical lubricators, wick, drip lubricators, bottle oilers, etc., in place of the open hole into which lubricant is poured.

Feeding should, wherever possible, be automatic, although this may be difficult at the present time, as the automatic devices may not be sufficiently available.

The safety factor employed when adjusting automatic feeds is probably high in normal times—this might be reduced under present conditions. It

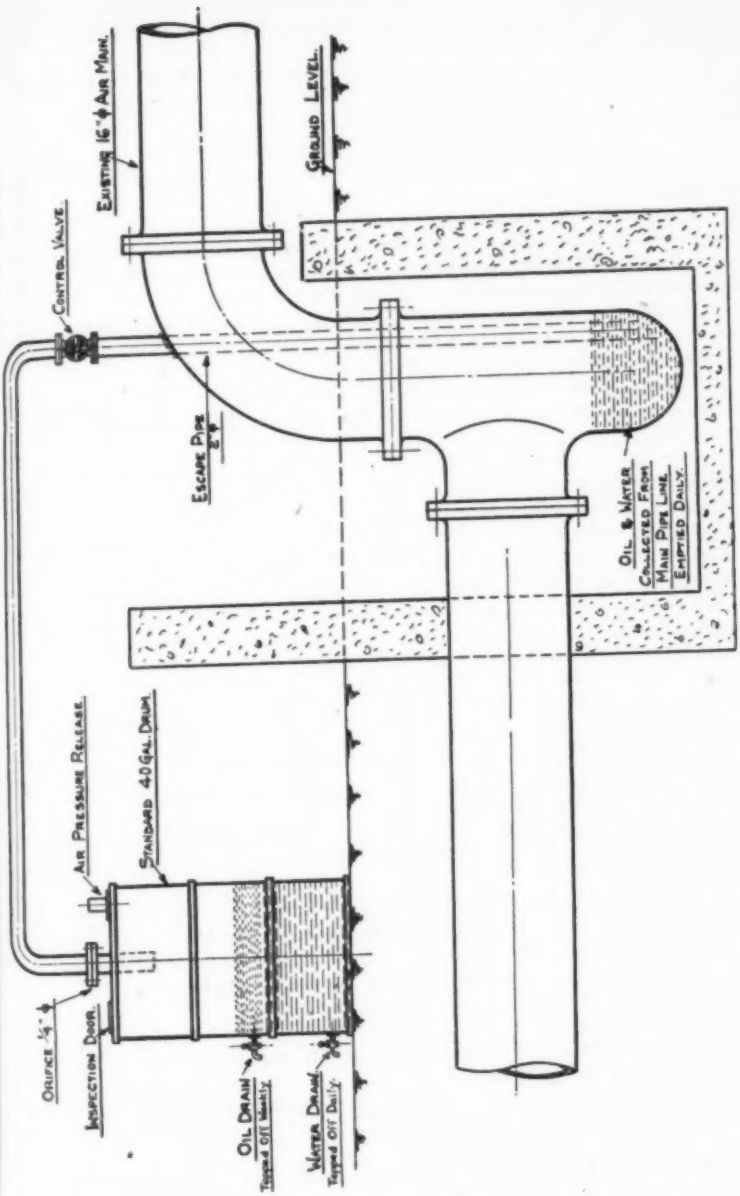
Existing 16" ϕ Air Main.
Ground Level.
Control Valve
Escape Pipe 2"ϕ
Oil & Water Collected From Main Pipe Line. Emptied Daily.
Air Pressure Release.
Standard 40 Gal. Drum
Orifice ¼"ϕ
Inspection Door.
Oil Drain Turned Off Weekly
Water Drain Turned Off Daily

FIG. 1.

is impossible to dictate rates of feed, but it is suggested that where greater supervision can be exercised, more sparing adjustments could bring about economies. (See below and Appendix.)

(i) *Air-Compressor Cylinders.*—Whilst formulæ are available for assessing the approximate average consumption of air-compressor cylinder oils, any general use of formulæ is dangerous, owing to the varying operating conditions and types of oils in service. The oil suppliers have from time to time submitted reports to mine officials in which recommended rates of feed for air-compressor cylinders and other items of equipment are given, and reference to these reports is suggested.

Oil which accumulates in air receivers should be collected, filtered, and re-used, as this lubricant is not subjected to severe conditions in its passage from the compressor cylinder to the receiver.

In rotary vane-type compressors the oil that is fed to the barrel, necessarily in large quantities, is blown out with the air, and a successful method of recovering it is shown on drawing No. 1.

(ii) *Steam-Engine Cylinders.*—To specify minima feeds is dangerous, and it is therefore suggested that the oil suppliers' reports referred to above be perused where these are available.

In the case of some winding plant, the total volume of oil delivered to cylinders and valves is too generous. There appears to be room for economy in such cases.

Generally speaking, it is not possible to reclaim oil carried over with the exhaust steam, owing to the majority of steam-cylinder oils in service being compounded, and therefore readily emulsifiable with the condensate.

(iii) *Locomotives.*—One of the chief sources of waste in connection with steam-cylinder oils is neglect to shut off the main steam-valve to hydrostatic lubricators when the locomotive is idle.

As a guide, average consumption figures are given in the Appendix (1). In connection with the wick oilers commonly fitted on locomotive journal bearings and side rods, reference should be made to section (iv) below.

The chief source of waste in axle-boxes is over-filling and the incorrect placing of the crescent pad at the back of the axle-box; both result in leakage past the wooden seal.

In the cases of locomotive and winding engine valve-gear, such as links, pins, bushes, etc., economies have been effected by fitting grease-cups or nipples.

(iv) *Wick Oilers.*—Wick oilers should be carefully regulated to develop their full value. It is a common mistake to feed more oil than is necessary. A correctly oiled bearing will show little or no oil running out at the ends, and it is necessary to supply only a small amount to replace loss.

The methods of regulating the feed are :

1. Increasing or decreasing the number of strands of wick.
2. Using larger or smaller yarns.
3. Using a tightly or loosely twisted or woven material for the wicks.
4. Applying pressure to the wicks.

Few operators realize how very sparingly the oil-feed can be made and yet meet the bearing requirements when the supply is uniform and con-

tinuous. Frequently, for medium and small-size bearings, a single strand of wick will supply more oil than is required.

Close regulation of a wick oiler is impossible without the use of a wire wick-holder or other means to assure that the discharge end of the wick will always be in its correct position. Wick oilers will continue to feed when plant is shut down, unless the wick be removed, and removal is facilitated by using the proper wire wick-holder. In cases where plant is to be shut down for lengthy periods, all wicks should be removed.

(v) *Bottle Oilers.*—One of the most economical devices for feeding oil to plain bearings is the bottle oiler; the application of bottle oilers to the general shafting of machine shops, etc., is suggested. Since the bottle oiler is inverted and air-tight, except for the spindle clearance, oil cannot leak out unless air enters. When the shaft is stationary, no air enters the bottle and no oil is lost. When in operation, the spindle of the bottle oiler is given a motion so slight that it can scarcely be detected. This motion is sufficient, however, to result in a pumping action which causes air to enter and the oil to leave the bottle at a very slow but uniform rate.

(vi) *Rock Drills.*—It is recommended that air-line lubricators for rock drills be set by the rock-drill fitter or other qualified person at the optimum position, and that the feed be soldered at that position with the object of avoiding change of feed by the underground user. The lubricator should at regular intervals be returned to the drill-fitters' shop to be examined. It has been found that the ambient temperature at different levels affects the viscosity of the oil sometimes to a degree which may necessitate change in the rate of feed at different levels if most economical consumption is to be attained.

Waste of rock-drill oils can be due to one or more of the following causes :

1. The careless filling of rock-drill lubricators underground.
2. The pouring away of oil from four-gallon containers in order to secure the tin.
3. The pouring of oil directly into the machine to boost the line-feed lubricator.
4. Failure to return the lubricators with the oil remaining in them.
5. The practice of the drill boys of bending and releasing air hoses in order to make the lubricators surge and feed momentarily a larger quantity of oil.

See Appendix (2).

(vii) *Air Motors, Air-operated Pumps and Drill Sharpeners.*—The introduction of air-line lubricators, or where these exist, correct adjustment of them might assist in conserving oil.

(viii) *Grease—Plain Bearings.*—As mentioned under item (iii) above, there are many bearings which could conveniently be converted to grease lubrication. It will be appreciated that no precise information can be given as to which bearings should be so converted.

The tendency of Natives to waste grease and oil is appreciated; it will be found frequently that a large amount of grease is accumulated under bearings due to over-feeding. The continual application of grease by high-pressure guns or through cups to conveyor idler bearings and the like is unnecessary, and investigation here is well worth while.

(ix) *Ball and Roller Bearings.*—Frequent greasing of these bearings by means of grease guns or cups is not always necessary, and in a number of cases these fittings can be removed, as better results will be obtained by packing the bearings at prolonged intervals. However, with certain designs of bearings a periodic turnover of the grease in the housing is necessary, and therefore, before grease-cups or other fittings are removed, it is advisable that the manufacturer or supplier of the bearing should be consulted.

(x) *Cocopan Axles.*—A large amount of oil is often wasted, both underground and on the surface, due to excessive oil being scraped off wheel or other types of lubricators. Whilst much of this oil is not recoverable, a certain percentage could be recovered by installing drip-trays for a certain distance on the inside of the track.

Application of grease by means of a brush has been found to be more economical than some of the present methods in use. It is suggested that in future, where convenient, mechanical lubricators on haulages could be placed at points where cars travel at the lowest speed, in order to avoid excessive splashing and waste.

(xi) *Open Gears.*—The most economical means of applying gear dressings to tube-mill spur-rings, classifier open-gears, etc., is by means of mechanical devices to control the quantity delivered to the teeth. Owing to non-availability of materials, a large number of gears are still dressed by hand, and in this connection the application of the lubricant, after heating, is achieved more economically by means of a brush than by pouring the lubricant on to the teeth.

(b) *Circulatory Systems—General Remarks and Care in Use.*

High-grade oils usually employed in circulatory systems cannot be worn out in the sense that their lubricating properties are destroyed; but metallic oxides, dust or grit, held in suspension, may render them unfit for further service in that condition. They should not be thrown away, as their continuous re-use is possible if the impurities are removed by some process of purification.

Even the best oils, when subjected to rapid circulation at high temperatures in the presence of collected impurities in a circulatory system, will oxidize gradually, and unless the impurities are removed, the rate of oxidation will increase. Therefore, the degree to which an oil will resist oxidation is an important question, and the correct treatment of oil in service will extend its useful life. There is a limit, however, to the period during which an oil can remain in service without filtering or renewing the charge, and the problem then resolves itself into one of assessing its further useful life. This can be done properly only by chemical and physical analysis, but as those steps would be usually impracticable on the mines, the oil supplier should be consulted in doubtful cases.

It must be borne in mind that the mere filtering of an oil from a circulatory system may not necessarily restore the oil to a condition which will prevent emulsification with water or the further deposition of sludge, and periodic tests are the only satisfactory means of determining its condition.

(i) *Compressor Crankcases.*—In the treatment of oil in service in crankcases of air compressors, it is good practice to withdraw several gallons from the lowest point in the system at weekly intervals and to pass this oil

through a filter. If a suitable type of filter is not available, the description and drawing No. 2 in Appendix (3) may be useful.

Filtered oil plus the necessary new oil can then be used as make-up every week. In this way, solids in suspension and a certain amount of settled sludge are kept at the minimum, and the rest period in the filter assists in maintaining the oil in good condition. Provided there is no leak in the oil-cooling system fitted to a machine, no water, other than that due to condensation from the atmosphere, is likely to gain access to the crank-case oil in a compressor or vacuum pump, and there is little danger of emulsification.

(ii) *Steam-Engine Crankcases.*—The chief sources of contamination of oil in vertical steam-engine crankcases are water and other impurities which gain access either by working down the piston-rod or by entry through the breathers. In an endeavour to reduce the effect of these impurities, it is customary during every shift to drain any accumulated water and deposits from the lowest point in the sump. At weekly periods, several gallons of oil should be withdrawn and passed through a filter as described above.

(iii) *Steam Turbines and Electrically-driven Turbo Compressors, etc.*—The oil from turbines should not be drained and replaced by new oil without previous reference to the supplier of the oil in service. In view of the importance of maintaining turbine oil in good condition, it is considered that advice should be sought on individual cases. A few of the more important points concerning the care of turbine oil are given in Appendix (4).

(iv) *Hoist Hydraulic Systems.*—In these systems the oil is seldom contaminated with water, but service conditions are severe in regard to oxidation. Because of the small passages in the control valves, etc., sludge is dangerous. Periodic examination of the oil-sump for deposited sludge is recommended.

(v) *Gear-boxes.*—Owing to the wide variety of types and sizes (splash and spray lubricated) of gear-boxes and the frequent use of compounded oils in worm gear-boxes, it is difficult to offer any general statement about limiting conditions for the oil. Experience has shown that charges of gear-box oils have had to be discarded, due to contamination with grease which resulted from the over-feeding of grease to bearings on these gear-boxes. Over-filling and the mechanical condition of oil-seals are factors that require attention, and which are often responsible for waste of oil, particularly in underground winches, etc.

(vi) *Gyratory Crushers.*—The chief source of contamination in most instances is rock dust, but in some cases of units fitted with water-seals there is a danger of emulsification if the seals are not maintained in proper condition. Ordinary gravity-type filters are often incorporated in the crusher oiling system, but as these filters will not usually remove water or any oil-oxidation products, periodic treatment of the entire charge is the safest procedure.

(vii) *Diesel Locomotives.*—The modern trend is to use oils containing additives in the crankcases of underground and surface Diesel locomotives, and care should therefore be taken to ensure that whatever filter is used, the method of treatment will not affect the additive. Owing to dilution by fuel and the presence of finely divided carbon, resulting from incomplete combustion, it is often difficult to reclaim oils from Diesel engine crankcases.

Generally speaking, where the quantity of crankcase drainings involved is not large, attempts should not be made to filter the oil. Drainings should be accumulated and the Group Buying Department kept advised.

(viii) *Ring-Oiled Bearings.*—Ring-oiled bearings (or collar or chain) are, in effect, miniature circulatory systems, and the oil from these bearings can be reclaimed. To avoid waste, the bearings should not be over-filled, otherwise the quantity of oil fed by the ring cannot be handled by the oil return grooves, and leakage occurs.

(ix) *Motor Transport.*—The crankcase oils from trucks and passenger-cars can be reclaimed, and should not be discarded, as suitable reclamation plants are in service. Ways and means to reduce consumptions have been advertised widely.

(x) *Transformer and Switch Oils.*—Owing to the importance of maintaining the quality of these oils, apart from the preservation of dry condition by centrifuge, filter presses, etc., they cannot generally be reconditioned completely by simple local processes. These oils can be sent to undertakings that specialize in complete treatment.

(xi) *Cutting Oils and Compounds.*—These media usually become contaminated only with metal shavings and dust, which can be removed by passing the cutting fluid through cotton-waste or gauze filters. A method of adjusting the strength of the emulsion is given in Appendix (5).

(xii) *Wire Ropes.*—Rope dressings collected inside engine-rooms from hoist-drums, etc., can be recovered, but in view of the tacky nature of these products, local reconditioning is usually out of the question. These products can be salvaged, and should be sent to undertakings specializing in this work. To avoid contamination and loss of rope dressings in service, steps should be taken, where possible, to prevent water impinging upon ropes or haulage ropes dragging through water or dirt.

III. Reconditioning of Oil.

It is desired to emphasize the view that no lubricants of any kind should be discarded, for it is considered that some further use can be found for all used products. In collection, care whould be exercised to segregate the various types and grades wherever this is feasible.

It is known that on many mines reconditioning methods are already in use successfully, and it is not intended to submit suggestions that would disturb such practice.

In fact, it is wellnigh impossible to offer recommendations covering the best methods to be employed for oil reconditioning, as such wide variations exist in the type and condition of used lubricants to be handled. In general, where doubt may exist as to what should be done with used lubricants, it is recommended that consultation with the supplier of the product in question is the first step to take.

Bearing in mind the foregoing view, it can nevertheless be stated that contamination by extraneous impurities is usually removed by the use of ordinary gravity-type filters. On the other hand, where decomposition products of the oil itself have to be removed, the selection of the most appropriate type of oil regenerator necessitates technical consideration.

Users should be warned against the indiscriminate use of oil-reclaiming devices when special types of lubricants containing inhibitors, additives, etc., are in service, otherwise there is likelihood that the quality of the lubricant may be impaired.

The reconditioning of greases is not generally practicable on the mines, nevertheless, no used grease should be discarded. When collecting such products, greases recovered from machinery housed in clean surroundings should not be mixed with those recovered from plant operating under unavoidably dusty conditions, where they will have been subjected to greater contamination. In the first instance, the cleaner greases could be employed again for axles of cocopans. In the second case—that of badly contaminated greases—the possibility of recovery should be made a matter of reference to the Group's head office.

By way of reminder, the following methods of oil treatment are mentioned.

1. Settling.
2. Washing.
3. Centrifugal separation.
4. Filtration—gravity or pressure filtration.
5. Chemical treatment.

IV. Alternative Grades and Inter-Changeability.

It is impracticable to draw up a schedule showing types and brands of oils that could be used as alternatives in place of the oil customarily used. Manifestly, this matter is related closely to the stock position, and any difficulty in obtaining supply of a particular lubricant should be referred to the oil supplier for advice as to alternatives.

V. General.

In any case where lubricants are in stock and where the mine holding such stock is not sure of the origin and the use to which they can be put, the matter should be referred to the Group Buying Department.

APPENDIX

(1) Steam Locomotives and Rolling Stock.

The following figures might prove of interest :

Cylinder-oil consumption per 100 miles running on English railways is 1·0–1·2 pints; French State 0·6–1·8; and the South African Railways and Harbours 1–2¼ pints (2¼ pints for the largest class 23 locomotives). An average figure for comparative purposes for mine locomotives would seem to be in the neighbourhood of 1 pint per 100 miles for cylinder oil only.

Motion and journal oil should average about 2 pints per 100 miles, and waste-packed axle-boxes consume approximately 1 pint of oil per 3000 miles.

(2) Consumption of Rock-Drill Lubricants.

In drawing comparisons of rock-drill lubricating-oil consumptions between different mines, this is often stated as so much per 100 feet drilled, but this does not take into account the penetration in inches per minute or the type of machine. As the quantity of oil fed to a jack-hammer by an air-line lubricator is a function of time of operation rather than of footage drilled, it would be preferable to arrive at a consumption figure based on time. For example, the 100 feet drilled could be divided by the penetration in feet per minute, and a factor arrived at which could give the fluid ounces consumed per hour of machine operation. This, it is felt, will give a more accurate basis for comparison of consumptions.

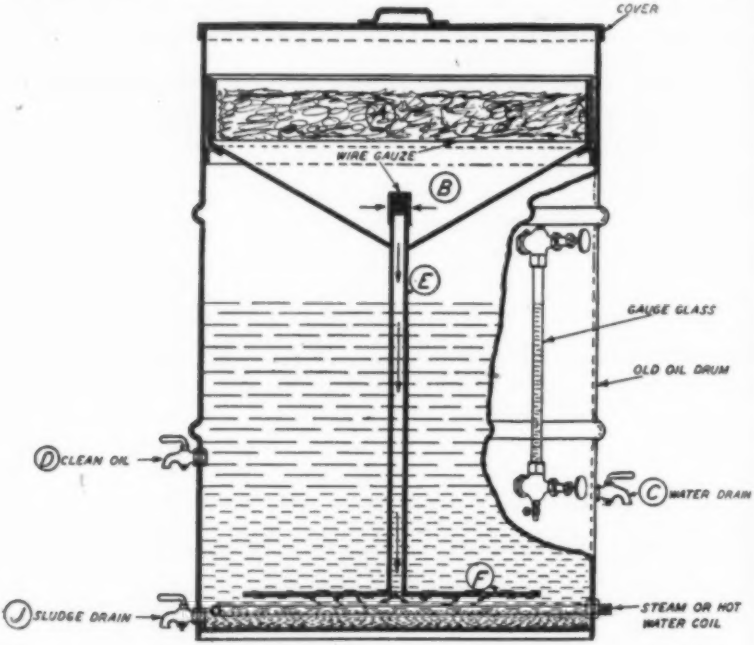

Fig. 2.

As the consumption of drifters is usually higher than that of jack-hammers, the ratio of jack-hammers to drifters used in any particular shaft or mine should also be considered, as this materially affects the overall consumption.

(3) Simple Gravity-type Filter.

Instructions for Installation and Operation.

It should be noted that this filter is not intended to supplant more comprehensive apparatus. Its function is to assist in maintaining oil in good condition during service.

The accompanying drawing No. 2 shows the construction of a simple, inexpensive oil-filter which can be made out of an old oil-drum.

The top compartment *A*, which is a circular iron tray with a gauze bottom, is filled with good, clean cotton or wool-waste tightly packed to within 1 inch of the top, thus providing sufficient space for the oil to spread over the surface. Before the filter is used the waste-packed compartment *A* and the funnel-shaped receptacle *B* are removed, and the body of the filter filled with water to a level indicated by the water-cock *C*. New oil is then poured in until the level rises to the filtered oil-cock *D* which should be approximately 2 inches above cock *C*. *B* and *A* are then replaced.

The oil to be filtered is poured into chamber *A*. It percolates through the filtering medium, passes the gauze screen, flows into the receptacle *B* and in turn passes through the gauze cap and down-pipe *E*; finally it gravitates through the perforated disc *F* (the holes in this disc should not be greater than $\frac{1}{4}$ inch diameter), and then rises through the water. The oil can then be drawn off through cock *D* ready for re-use. Any impurities settling at the bottom of the filter are withdrawn through cock *J*.

Filtering rate is increased if the water in this filter is heated up to about 180° F. by means of a steam- or hot-water-coil as shown. This thins the oil and speeds settling of entrained impurities. Heating the oil to more than 180° F. will set up convection currents in the oil which hinders precipitation.

The oil when filtered will be darker than its original colour, but this has no effect whatsoever on its lubricating properties.

The waste in chamber *A* will need renewing after being in use for some time, but this is best judged by its condition.

(4) Steam Turbines.

The length of service of which the oil in the circulatory system of a steam turbine is capable is proportionate to the care given to the oil. The following points deserve attention :—

(*a*) *Oil and Water Leakages.*—Keep to the minimum leakage of oil at pedestal seats, pipe-joints, etc., and of water into the oil from steam- and water-glands, etc.

Prevent leakage of oil and water in the oil-cooler.

Draw off all water from the system at regular and frequent intervals.

(*b*) *Oil Inspections.*—Once a week take representative samples of the oil in circulation, preferably in test-tubes, from :—

(i) pressure oil line just before cooler ; or
(ii) return oil line from bearings ; or
(iii) oil reservoir above level of pump suction.

The samples should be drawn from the same point each time and each sample should be labelled.

Keep each sample for four weeks, and compare the condition of the oil during progressive service.

(*c*) *Oil Treatment.*—Where automatic by-pass filtration is not installed, withdraw (preferably from the lowest point in the system), daily or weekly,

according to the operating conditions, a portion of the oil circulation for treatment by centrifuge, or by settling or filtration or both.

Maintain the oil level by the addition of new or treated oil.

(*d*) *Temperatures.*—Take daily the temperatures of the oil and of the water entering and leaving the oil-cooler. Changes in these temperatures in relation to changes in atmospheric temperatures will indicate whether or not the oil-cooler is performing its function properly.

Take also daily the engine-room and bearing temperatures. An increase or decrease in engine-room temperature should be reflected in a relative variation in oil-circulation temperature.

(*e*) *Cleaning the System.*—The periods for cleaning the turbine system should be determined and regulated by :—

Marked increase in the amount of deposits shown by comparing oil samples—see (*b*).

Marked increase in the rate of impurities deposited in filters—see (*c*).

Marked change in temperature records—see (*d*) and (*f*).

Clean the settling-tanks and filters at regular and frequent intervals.

It is dangerous to use waste for cleaning oil systems, Mutton cloths, or similar materials, should be used for this purpose.

(*f*) *Log Book.*—Keep careful records by date : of the quantities of water drawn off from the system (item (*a*)) ; of the samples drawn for inspection (item (*b*)) ; of the oil withdrawn for treatment and returned to the system respectively, and of new oil added (item (*c*)) ; of temperatures (item (*d*)) ; and of the cleaning and re-filling of the entire system (item (*e*)).

The above points, with the exception of references to steam, apply also to oil in circulation in Electrically-driven Turbo Compressors, etc.

(5) Cutting Oils and Compounds.

During machining operations heat is generated at the cutting edge of the tool. Where soluble oil emulsions are used, high temperatures may bring about partial evaporation of the water, upsetting the proportion of oil to water. In other instances oil may be lost resulting in a weakening of the emulsion. A point may be reached where the emulsion separates and the entire charge of cutting fluid is discarded. To test the strength of the emulsion a sample should be placed in a graduated flask and a few drops of dilute sulphuric acid added. This will usually break the emulsion, thus enabling the strength of the emulsion, *i.e.*, proportion of water to oil, to be estimated. The necessary amount of oil or water to be added to bring the emulsion back to the correct proportions can then be calculated.

A NOTE ON OIL FIRES.*

By A. F. Dabell.

Fire from liquid fuel is more easily controlled than that from solid combustibles, and calls for less man-power where drainage facilities are provided. Fire from a solid combustible must be fought to a conclusion upon the site of its fuel.

When liquid, the fuel may be transferred at will to chosen sites and extinguished by subtle measures. For example, if a so-called inflammable liquid in a container open at the top and fitted with a drain-cock at the bottom becomes ignited, the duration of the fire may be regulated by draining away the liquid. If drainage be made through a pipe leading to a second container, the fraction of liquid lost by fire will be proportional to the time taken by the transfer. If a barrel of petrol at ground level be connected to another below ground level, similar extinction and salvage are obtainable in case of fire.

Where inflammable fluids are stored in congested areas, their containers can be connected to receptacles of equal capacity (upon waste ground) at lower level, and then, in the event of fire, extinction and salvage are assured.

The same applies to installations of the largest dimensions. Moreover, given fire within any enclosure, it can be starved to death by draining its fuel through a wall or bank. Even a sea of fire from fugitive oil may be brought under control by guttering to a sump with pipe entry, and more readily so if guttering of herring-bone pattern be made in good time.

Common to all installations :—

1. Where topography, expense, etc., are a deterrent, liquid responsible for the fire may be run into the earth by way of a pit or bore sunk to the first water-bearing or absorbent stratum in its vicinity.
2. The greater the distance between containers, the less the risk of re-ignition of vapour released.
3. The period of flickering expiry of burning vapour in the original container will be shortened by the insertion of a gas-trap in the pipeline.

* Received 29th October, 1942.

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